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Himco Dump Superfund Site
Alternative Analysis Study
Final Draft Proposal

Prepared For:

EPA United States Environmental Protection Agency

and

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IDEM

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Table of Contents

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1. Project Background

The Himco Dump Superfund Site is located at County Road 10 and the Nappanee Street Extension in Cleveland Township, adjacent to the City of Elkhart, Elkhart County, Indiana. Himco Waste Away Services operated the landfill between 1960 and September 1976. In 1976 the landfill was closed and covered with approximately one foot of sand overlying a calcium sulfate layer. In February 1990, the Himco Dump site was placed on the National Priorities List (NPL) and designated a Superfund site.

The Record of Decision (ROD) was finalized in 1993. The major components of the RODs selected remedy included:

- Construction of a composite barrier, solid waste landfill cover system;
- Institutional controls to limit land and ground water use on landfill property;
- Installation of an active landfill gas collection system including a vapor phase carbon treatment and enclosed flare systems; and
- Monitoring of ground water to ensure remedial action effectiveness and to evaluate the need for further ground water treatment.

The selected remedial action is protective of human health and the environment and satisfies the statutory requirements of Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. CERCLA requires that the selected remedy comply with all applicable, relevant and appropriate requirements (ARARs) imposed by Federal and State environmental laws. Due to hazardous substances present in leachate, chemical specific requirements of the Resource Conservation and Recovery Act (RCRA) are deemed relevant and appropriate.

RCRA Subtitle C establishes minimum recommended performance criteria for hazardous waste cover systems. Alternatives to this criteria are allowed provided they are equivalent to RCRA Subtitle C recommendations or their intent. The objective of these criteria are to limit water infiltration through waste and therefore minimize leachate generation, which could potentially contaminate ground water. One RCRA Subtitle C and ROD criterion aimed at minimizing leachate generation is construction of a composite barrier. A composite barrier consists of a low hydraulic conductivity geomembrane (liner material) and soil (barrier) layer. RCRA Subtitle C also recommends the liner material be in intimate contact with a barrier layer.

The U.S. Army Corps of Engineers (USACE) – Omaha District completed documents for the remedial action at Himco Dump Superfund Site in April 1998. The 54.15-acre landfill cover system for the current design, Figure 1, complies with ROD Alternative 4 and RCRA Subtitle C recommendations.

2. Alternative Analysis Study Background

In December 1999, a meeting was held between representatives of the U.S. Environmental Protection Agency (EPA), Indiana Department of Environmental Management (IDEM), City of Elkhart, Potentially Responsible Party (PRP), and USACE – Omaha District.

This Alternative Analysis Study (AAS) was initiated as a result of this meeting. The AAS evaluation was performed to determine an alternative cover system cross section for the Himco Dump Superfund Site that meets the intent of RCRA Subtitle C and is acceptable to the EPA and IDEM. The Hydrologic Analysis of Landfill Performance (HELP) Model was used to evaluate alternative cover system cross sections, as described in Section 5. Criteria for evaluating alternative cover systems are protection of human health and the environment (hydrologic efficiency), compliance with State and Federal ARAR's, the remedy resulting in a permanent solution, cost effectiveness, and compatibility with future reuse.

The Himco Dump Superfund Site AAS evaluated only the cover system component of the ROD. Other ROD components, as stated in Section 1 and in the USACE – Omaha District design package, were not considered and remain as part of the site remedy. Based on additional ground water and soil gas data collected, see Section 8, certain components of the current USACE – Omaha District design package may require additional evaluation.

3. Future Reuse

The EPA supports redevelopment of superfund sites through their Superfund Redevelopment Program. The Himco Dump Superfund Site may be developed for future reuse upon final closure per the ROD or its revision. Potential future reuse options should be identified to aid in designing a cover system that will meet the alternative recommendations provided below without compromising the cover systems ability to protect human health and the environment and compliment future reuse enhancements. Funding for future reuse enhancements to the cover system are to be provided by the developer, not the PRP.

4. Alternative Recommendations

Alternative recommendations for the cover system at the Himco Dump Superfund Site are provided for the cover soil, drainage layer, liner material, and barrier layer. Alternative recommendations are protective of human health and the environment, satisfy the intent of RCRA Subtitle C regulations, are adaptable for future reuse, and result in a more cost effective cover system for the Himco Dump Superfund Site.

4.1. Cover Soil

4.1.1. Slope

RCRA Subtitle C recommends a cover slope between three and five percent, with a minimum slope of three percent after allowing for consolidation of underlying materials. The current design meets IDEMs final cover slope requirement of four percent. The final grade slope shall be determined by the intended future reuse while meeting all alternative recommendations presented below.

4.1.2. Thickness

RCRA Subtitle C recommends a vegetation/cover soil thickness (above geosynthetic materials) of 24 inches. This recommendation will apply to the Himco Dump Superfund Site. Excavation below this recommended cover thickness will not be allowed. Deep-rooted vegetation, such as trees, may also not be allowed as part of a future reuse option. Future reuse enhancements may require additional material to be placed on the cover system.

RCRA Subtitle C recommends, and IDEM requires, the cover system consist of a minimum of six-inches of topsoil. Topsoil for the Himco Dump Superfund Site may be reduced to a minimum of four-inches. This may be beneficial for future reuse options such as a golf course or ball field where a minimal topsoil thickness with an underlying rapid infiltration layer is desirable. Design of the cover system must evaluate vegetation rooting depth and precipitation requirements.

4.2. Drainage Layer

4.2.1. Slope

RCRA Subtitle C recommends a slope between three and five percent with the minimum drainage layer slope of three percent after settlement/consolidation of the underlying materials. The current design slope is four percent.

The recommended design drainage layer slope for the Himco Dump Superfund Site cover system is between four and five percent. This will allow for some settlement/consolidation within the landfill while meeting the RCRA Subtitle C recommendations and providing greater protectiveness of human health and the environment than a flatter slope.

The cover system design for the Himco Dump Superfund Site should include a settlement analysis to support the design slope. Knowledge of potential future reuse enhancements would aid in the settlement analysis as this could affect the selected design slope.

4.2.2. Thickness and Hydraulic Conductivity

RCRA Subtitle C recommends the drainage layer consist of a granular material with a minimum thickness of 12 inches and a minimum saturated hydraulic conductivity of 1×10^{-2} cm/sec, or a geosynthetic drainage layer meeting these hydraulic characteristics. The Himco Dump Superfund Site cover system drainage layer will be constructed in accordance with the RCRA Subtitle C recommendations. Due to a lack of locally available granular materials which meet these recommendations, the most cost effective drainage layer material is a geosynthetic, commonly referred to as a geonet.

4.3. Liner Material

RCRA Subtitle C recommends a 20-mil geomembrane liner in intimate contact with a low hydraulic conductivity soil (barrier) layer for cover systems. The Himco Dump Superfund Site cover system will consist of a 40-mil (1.0 mm) geomembrane consistent with the ROD.

4.4. Barrier Layer

RCRA Subtitle C recommends a compacted natural or amended soil with a minimum thickness of 24 inches and a maximum saturated hydraulic conductivity of 1×10^{-7} cm/sec. Materials meeting this recommendation are commonly referred to as a compacted clay liner (CCL). Geosynthetic clay liners (GCLs) are commonly used to replace CCLs in cover applications, as is the case for the current design. Either of these materials is intended to be in intimate contact with the liner material.

A barrier layer may not be required provided it can be demonstrated that alternative cross sections are protective of human health and the environment and complies with the intent of RCRA Subtitle C recommendations.

5. Hydrologic Evaluation of Landfill Performance Modeling

The Hydrologic Evaluation of Landfill Performance (HELP) model Version 3.07 (01 November 1997) was used to estimate the average annual percolation/leakage through various cover system configurations as part of the Himco Dump Superfund Site AAS. The hydrologic efficiency of each cover system was calculated as an indication of the cover systems overall effectiveness. Hydrologic efficiency of a cover system is defined as the percentage of total precipitation that does not percolate/infiltrate through the cover system. A cover system with high hydrologic efficiency results in greater protectiveness of human health and the environment by decreasing the percolation/infiltration through the cover system, and therefore potential for leachate generation.

The Himco Dump Superfund Site AAS evaluated the water balance of the cover system. Design issues such as vegetation considerations, head on the liner material or barrier layer, or slope stability were not evaluated. These issues would require additional analyses during design of the final cover system for the project.

Cover system HELP modeling was performed by varying the following parameters: vegetation and water storage layer thickness, precipitation, drainage layer, liner material, barrier layer, and slope as indicated in Table 2 and Figure 3, and discussed below. Table 3 summarizes precipitation variation as discussed in Section 5.1. HELP modeling summaries are presented in Tables 4 and 5.

Modeling summaries presented in this report meet the Himco Dump Superfund Site AAS alternative recommendations presented in Section 4, Alternative Recommendations. All modeling variations used to develop alternative recommendations are described below.

Modeling simulated drainage conditions within the 54.15-acre landfill assumed 100 percent of the area allowed runoff. Cover soil thickness was modeled as 24 inches with the exception of ROD Alternative 2 which has a cover soil thickness of 18 inches. The surface and drainage layer slopes were modeled with the same slope, i.e. with a constant cover soil thickness. To simplify the modeling, one vertical on four horizontal (1V on 4H) side slopes were also modeled at the cover and drainage layer slope. This is conservative from a percolation/infiltration perspective as steeper side slopes would increase runoff and decrease infiltration. Since side slopes account for a minor percentage of the total landfill cover surface area, this conservatism is minimal.

5.1. Precipitation

All simulations were performed for a period of 30 years. Modeling was performed using 30 years of synthetic weather data (evapotranspiration, precipitation, temperature, and solar radiation) coefficients for Fort Wayne, Indiana. Synthetic precipitation and temperature data was generated from monthly mean data (1951 through 1980) from the National Oceanic and Atmospheric Administration (NOAA) *Climates of the States,* for South Bend, Indiana. These locations were selected due to their geographic proximity to the project site. The synthetic precipitation data generated from this monthly mean data was used for the "Natural" precipitation scenario.

Since future reuse could consist of a golf course, an irrigated scenario was also modeled. For the "Irrigated" precipitation scenario, the normal mean monthly precipitation input for the "Natural" case was modified. Synthetic precipitation was generated from the modified input. The HELP Model assumes the Fort Wayne, Indiana, growing season is between Julian dates of 116 and 289

(April 25 to October 15, 2000). The normal mean monthly precipitation for the months of April through October were increased to provide 0.1 inch of precipitation per degree Fahrenheit of normal mean monthly temperature. Due to this modification, the annual precipitation increased from 37.54 inches (7,379,293.5 cubic feet) to 55.89 inches (10,986,121.0 cubic feet). This 49 percent increase in precipitation results in greater water percolation through soil layers and percolation/leakage through the cover system. Table 3 summarizes the normal mean monthly precipitation input for both scenarios.

5.2. Vegetation

The HELP Model incorporates vegetative cover via a leaf area index (LAI). The LAI is the dimensionless ratio of actively transpiring vegetation to the nominal surface area of the cover. Simulations were performed with either a LAI of 2.0, representative of a fair stand of grass, or 3.5 which is representative of a good stand of grass.

Simulations with a fair stand of grass were modeled with an evaporative zone depth of 20 inches and received "Natural" precipitation. For the good stand of grass simulations, the evaporative zone depth was increased to 24 inches and precipitation was increased to the "Irrigated" case.

The vegetation layer was modeled as a four or six-inch thick vertical percolation layer of silty sand, SM, as classified by the Unified Soil Classification System (USCS), material for all simulations. This material has a saturated hydraulic conductivity of 7.2 X 10^{-4} cm/sec.

For all simulations, the Soil Conservation Service (SCS) runoff curve number was computed from a specified curve number of 74.0 for a surface slope of two or four percent and a slope length of 500 feet. The SCS runoff curve number is a function of the surface slope, length, vegetative cover, and surface soil texture. The model uses the SCS curve number to compute the quantity of runoff. Water that does not runoff either evapotranspires or infiltrates. For a given surface slope, length, and soil texture, an increase in vegetative cover decreases the SCS runoff number, resulting in increased evapotranspiration and infiltration.

5.3. Cover System Configurations

The cover system configurations modeled were based on ROD Alternatives 2 and 4 and a soil cover. ROD Alternatives 2 and 4 were modeled as they define two cover system alternatives for the Himco Dump Superfund Site. ROD Alternative 1 consists of No Action and ROD Alternative 3 consists of the ROD Alternative 2 cover system with collection of leachate and off site disposal.

5.3.1. ROD Alternative 2

The cover system of ROD Alternative 2 consisted of (from top to bottom):

- 18 inches of vegetated soil;
- Six inch sand drainage layer; and
- Two feet of low permeability clay.

ROD Alternative 2 was modeled as (from top to bottom):

- Six inches of topsoil (vegetated layer);
- 12 inches of vegetated soil (water storage layer);
- 6 inch sand drainage layer; and
- Two feet of low permeability clay.

Two sand materials were evaluated for the drainage layer, as described in Section 5.4.2.1. Sand.

ROD Alternative 2 was eliminated as a potential alternative due to hydrologic inefficiency. The ROD Alternative 2 simulations estimated average annual percolation/leakage through the cover system is in excess of 200,000 cubic feet (1.5 million gallons).

Cost and freeze/thaw concerns of the CCL were also considered. The current design incorporated a GCL rather than a CCL due to lower cost and superior performance. The increased cost of a CCL is due to the lack of locally available clay sources and increased construction and quality control/assurance costs. The Elkhart Public Works and Utilities indicate that the frost depth is usually 36 to 48 inches and occasionally up to 60 inches in this area (USACE, 1998). A Corps of Engineers Guidance Document (USACE, 1986) states the maximum depth of frost penetration is 64 inches for Fort Wayne, Indiana, which is located approximately 80 miles southeast of the site. Research (Othman, 1994) has shown that the hydraulic conductivity of a CCL increases by up to three orders of magnitude after being subjected to a few freeze-thaw cycles. The increased hydraulic conductivity increases the quantity of leachate generation over the as constructed CCL.

All ROD Alternative 2 simulations were modeled with a four percent slope since this cover system configuration was eliminated prior investigating the two percent slopes.

5.3.2. ROD Alternative 4

The current cover system design is based on ROD Alternative 4 and complies with RCRA Subtitle C recommendations. The cover system of ROD Alternative 4 consisted of (from top to bottom):

- 18-inches of vegetative soil layer;
- Six-inches of sand drainage layer;
- 40-mm HDPE geomembrane;
- Two-foot low permeability clay liner; and
- One-foot foundation layer to achieve four percent minimum grade.

The intent of the ROD was to require a 40-mil thick geomembrane rather than a 40-mm (1,575-mil) thick geomembrane. The current cover system design incorporated this ROD modification, substituted a geosynthetic drainage layer for the six-inch thick sand drainage layer, and substituted a geosynthetic clay layer for the natural (compacted) clay layer. The current cover system design consists of, and was modeled as (from top to bottom):

- Six-inches of topsoil (vegetative layer);
- 18-inches of select fill (water storage layer);
- Geonet drainage layer;
- 40-mil geomembrane;
- Geosynthetic clay liner; and
- One-foot foundation layer (subgrade).

The current cover system design, shown in Table 1 and Figure 2, was evaluated for comparative purposes. The majority of the AAS simulations consist of variations of the drainage layer, liner material, and barrier layer of this cross section as described below.

The ROD Alternative 4 (current design) cover system meets or exceeds the alternative recommendations presented in Section 4.

5.3.3. Soil Cover

A soil cover was also simulated as this would be the least cost cover system alternative. The soil cover was modeled as (from top to bottom):

- Six-inches of topsoil (vegetated layer); and
- 18-inches of select fill (water storage layer).

The water storage layer was modeled as clayey sand, SC, as classified by the USCS. This material was modeled with a saturated hydraulic conductivity of 1.2×10^{-4} cm/sec and was chosen because it is representative of locally available material and is therefore cost effective.

The soil cover alternative was eliminated due to excessive hydrologic inefficiency. The soil cover alternatives estimated average annual percolation/leakage was in excess of 1.5 million cubic feet (11.2 million gallons).

5.4. Layer Variations

Layer variations were considered for the drainage layer, liner material, and barrier layer.

The HELP Model allows a layer to serve one of four functions:

1. Vertical percolation;
2. Lateral drainage;
3. Barrier soil liner (barrier layer); or
4. Flexible membrane liner (liner material).

The HELP Model assumes flow in vertical percolation layers is by unsaturated vertical drainage that occurs downward due to gravity and upward due to evapotranspiration. The vegetative and water storage layers of the cover system were modeled as vertical percolation layers. For simulations with a liner material but without a barrier layer, a vertical percolation layer was placed below the liner material to achieve realistic leakage rates through the cover system. Lateral drainage layers are located above liner materials and promote internal drainage laterally out of the cover system. Lateral drainage layers flow vertically, as with vertical percolation layers, however saturated lateral drainage is also allowed. The HELP Model assumes barrier layers are saturated at all times. Leakage through a barrier layers is downward and occurs only when positive (driving) head is present on the upper surface of the barrier layers. Barrier layers, where present, consisted of a compacted clay liner (CCL) or a geosynthetic clay liner (GCL). Liner materials are essentially impermeable layers that limit vertical percolation through its manufacturing or installation defects. Vertical percolation occurs only when positive (driving) head is present on the layer. The liner material, where present, was modeled as a geomembrane or asphalt pavement. Modeling percolation/leakage values through the cover system were defined as that through the:

1. Barrier layer where present;
2. Liner material where present without a barrier layer; or
3. Soil cover.

Default HELP Model material characteristics were used for all layers with the exception of the asphalt pavement liner material alternative. Material characteristics consist of total porosity, field capacity, wilting point, and saturated hydraulic conductivity. Total porosity is the volumetric water content, i.e. volume of water per total volume. Field capacity is the volumetric water content remaining after subjected to gravity drainage without additional water. Wilting point is the lowest volumetric water content that is available for plant transpiration. These factors define moisture storage and relative unsaturated hydraulic conductivity material characteristics. Saturated hydraulic conductivity is the effective flow velocity through a saturated porous media.

5.4.1. Cover Soil

5.4.1.1. Topsoil

Topsoil was modeled as silty sand, SM, as defined by the USCS. This material is HELP Model default material texture six and has a saturated hydraulic conductivity of $7.2X10^{-4}$ cm/sec. All simulations were modeled with six inches of topsoil. Topsoil was also modeled as four inches thick for the geonet drainage layer alternatives modeled as indicated in Figure 3. The select fill thickness was increased to 20 inches for these simulations to maintain a cover soil thickness of 24 inches.

5.4.1.2. Select Fill

Select fill was modeled as clayey sand, SC, as defined by the USCS. This material is HELP Model default material texture 10 and has a saturated hydraulic conductivity of $1.2X10^{-4}$ cm/sec.

5.4.2. Drainage Layer

All simulations with a drainage layer were modeled as a sand material or geonet with a slope of four percent and a slope length of 500 feet. The drainage layer was also modeled at a slope of two percent for the geonet drainage layer alternatives as indicated in Figure 3. The two percent slope scenarios were eliminated due their decreased hydrologic efficiency. The additional percolation/leakage through the cover systems with two percent slopes results in a reduction in protectiveness of the human health and the environment via potential ground water contamination. The additional leakage was not deemed worth the cost savings realized by the flatter slopes (less than $2,000 per acre due to reduced fill requirements below the cover system). One of the major components of the ROD consists of ground water monitoring to ensure remedial action effectiveness and to evaluate the need for further ground water treatment. Should ground water treatment become required, this additional leakage would result in increased treatment costs for the PRP.

5.4.2.1. Sand

All sand drainage layers were modeled as 12 inches in thickness, as recommended by RCRA Subtitle C, with the exception of ROD Alternative 2 simulations. Two sand material types were evaluated for the drainage layer. One sand material met the RCRA Subtitle C recommended minimum saturated hydraulic conductivity of 1.0×10^{-2} cm/sec. This material classifies as poorly graded sand, SP, as defined by the USCS. The drainage layer was also modeled as clayey sand, SC, as classified by the USCS. This material was modeled with a saturated hydraulic conductivity of 1.2×10^{-4} cm/sec and was chosen as an option because it is locally available.

The sand drainage layer alternatives were eliminated due to cost and hydrologic efficiency considerations. Estimated average annual percolation/leakage with a SP drainage layer ranged from 344 cubic feet (2,570 gallons) for the simulation with fair vegetation, "Natural" precipitation, geomembrane liner material and GCL barrier layer to 318,920 cubic feet (2,385,687 gallons) for the simulation with good vegetation, "Irrigated" precipitation, no liner material, and a CCL. For the SC drainage layer simulations, estimated average annual percolation/leakage ranged from 1,026 cubic feet (7,675 gallons) for the simulation consisting of fair vegetation, "Natural" precipitation, geomembrane liner material, and GCL barrier layer to 432,900 cubic feet (3,238,317 gallons) for the good vegetation, "Irrigated" precipitation, MatCon™ liner material, and no barrier layer.

5.4.2.2. Geonet

All geonet drainage layers were modeled with HELP geosynthetic characteristic number 20. This material has a saturated hydraulic conductivity of 10 cm/sec.

5.4.2.3. No Drainage Layer

A drainage layer was not modeled for the soil cover alternative. Due primarily to the limited hydrologic efficiency, the no drainage layer alternative was eliminated for use at the Himco Dump Superfund Site. The soil cover alternatives estimated average annual percolation/leakage was in excess of 1.5 million cubic feet (11.2 million gallons).

5.4.3. Liner Material

Liner materials evaluated for the AAS consisted of a geomembrane, asphalt pavement, or no liner material.

5.4.3.1. Geomembrane

Cover geomembranes were modeled as 40-mil high-density polyethylene (HDPE), consistent with the ROD. Geomembrane defects were modeled consistent with HELP Modeling analysis for the current design. All geomembranes were modeled as having manufacturing quality assurance/quality control (QA/QC) with four pinhole defects per acre. Geomembrane installation defects were modeled as three per acre, consistent with "good" installation quality as defined by the HELP model. Installation quality assumptions are consistent with state-of-the-art materials and equipment, and construction QA/QC. The degree of intimate contact between the geomembrane and underlying materials was modeled as "good". Intimate contact is a function of subgrade smoothness and geomembrane installation wrinkle control during construction. Good intimate contact assumes a well-prepared, smooth subgrade and geomembrane wrinkle control sufficient to ensure good contact between the geomembrane and adjacent hydraulic barrier layer which limits the drainage rate through any defects.

According to HELP Model engineering documentation (Schroeder, 1994), the HELP model calculates geomembrane leakage based on methods developed by Giroud and Bonaparte (1989) as discussed in their papers *Leakage through Liners Constructed with Geomembranes - Part I Geomembrane Liners, Part II Composite Liners; and Technical Note.* This paper defines manufacturing defects as being typically smaller than the thickness of the geomembrane. Since geomembranes are typically 40 mils thick or greater, the HELP model defines manufacturing defects as having a diameter of 40 mils (0.04-inch) resulting in a defect area of 0.0012 in^2. Giroud and Bonaparte (1989) state that manufacturing defects were more typical with original, less sophisticated, geomembrane manufacturing techniques and that current manufacturing and polymerization techniques have made manufacturing defects less common.

Giroud and Bonaparte (1989) define installation defects to be equal to or greater than the thickness of the geomembrane and recommend a 20 x 5 mm defect, resulting in an area of 1 cm^2 (0.16 in^2) as a conservative liner defect for projects with an intensive construction QA/QC program. The HELP model uses this recommended installation defect area. Giroud and Bonaparte (1989) recommend one or two installation defects per acre for projects with intensive construction QA/QC programs. Giroud and Bonaparte (1989) also recommend 10 or more installation defects per acre for projects where quality assurance is limited to spot checks or when environmental difficulties occur during construction.

Freeze-thaw testing of geomembranes and their respective seaming methods under constrained and unconstrained incubation has resulted in no statistically significant change in the tensile behavior (Comer, 1997).

5.4.3.2. Asphalt Pavement

Asphalt pavement, MatCon™, was also modeled in lieu of the 40-mil HDPE geomembrane. MatCon™ consists of a proprietary, modified asphalt pavement mixture. The owner (http://www.wilderconstruction.com/matcon) claims the void ratio of conventional asphalt pavement (six to eight percent) can be reduced to less than three percent with MatCon™ binder and material requirements. The owner also claims a MatCon™ hydraulic conductivity of less than 1 X 10^{-8} cm/sec, resulting primarily from the decrease in void ratio in comparison to conventional asphalt pavement. Since no default HELP Model characteristics were available for MatCon™, one was created using the above values suggested by MatCon™ literature. The MatCon™ was modeled with a thickness of four inches. Defects used for the 40-mil HDPE geomembrane were also used for the MatCon™ material.

Asphalt pavement (MatCon™) was eliminated primarily based on cost considerations. A four inch thick layer of MatCon™ costs approximately $106,000 per acre. Inclusion of the required base and subbase courses for the MatCon™ asphalt system increases the cost to approximately $175,000 per acre.

5.4.3.3. No Liner Material

No liner system was modeled for the ROD Alternative 2 and soil cover alternatives. These alternatives were eliminated due to hydrologic efficiency considerations. The ROD Alternative 2 simulations estimated average annual percolation/leakage through the cover system in excess of 200,000 cubic feet (1.5 million gallons). The soil cover alternatives estimated average annual percolation/leakage was in excess of 1.5 million cubic feet (11.2 million gallons).

5.4.4. Barrier Layer

Barrier layer materials evaluated consisted of a CCL, GCL, and no barrier layer.

5.4.4.1. Compacted Clay Liner

The CCL was modeled as a 24-inch thick layer of high plasticity clay, which classifies as CH according to the USCS. This material corresponds with soil characteristic 15 of the HELP Model and has a saturated hydraulic conductivity of 1×10^{-7} cm/sec.

5.4.4.2. Geosynthetic Clay Liner

A GCL was also substituted for the CCL as GCLs are commonly used for barrier layers in cover applications. Current research (Daniel, 1997) indicates three freeze-thaw cycles do not significantly change the hydraulic conductivity of GCLs. The GCL was modeled as HELP model soil characteristic 17 that is 0.20-inch thick with a saturated hydraulic conductivity of 3×10^{-9} cm/sec.

5.4.4.3. No Barrier Layer

The barrier layer of the ROD Alternative 4 cover system configurations was eliminated to determine its effect on the average annual percolation/leakage. For these simulations, a vertical percolation layer was placed below the geomembrane. Modeling without the vertical percolation layer below the geomembrane would result in a free flow condition which would over predict the geomembrane leakage and therefore leachate generation. Due to its local availability, the vertical percolation layer was modeled as clayey sand, SC, as classified by the USCS. This material was modeled with HELP Model default soil characteristic number 10, which has a saturated hydraulic conductivity of 1.2×10^{-4} cm/sec. The average annual percolation/leakage rate of the current design and ROD Alternative 4 cover system configurations that meet the alternative recommendations are presented in Tables 4 and 5.

The soil cover scenarios also were modeled without a barrier layer as one would not be present in this scenario. The soil cover alternative was eliminated due to hydrologic efficiency considerations. The soil cover alternatives estimated average annual percolation/leakage was in excess of 1.5 million cubic feet (11.2 million gallons).

6. Cost Estimate

A cost estimate was performed for the current cover system and the geonet drainage layer alternatives. The unit cost for each cross section evaluated is indicated in Figures 2 and 3 and Tables 4 and 5. The cost estimates assume borrow sources for topsoil, select fill, and foundation fill are reasonably close to the project site and random fill is on-site and sufficient to achieve the proper grades. The cost estimate includes only construction costs, i.e. no escalation, contingencies, or supervision, inspection and overhead (SIOH) are included.

The cost estimates do not consider other features associated with the project such as clearing and grubbing, erosion control, landfill gas extraction system, or wetland mitigation. The cost estimate is intended to provide a relative unit cost between cover systems and is not intended to be a final cost estimate for the cover systems.

The quantities used for the cost estimates were based on the 90 percent design quantities. For the two percent slope scenarios, the random fill quantity was reduced by approximately 20 percent from the volume required to achieve four percent slopes. This reduction was based on a possible grading scenario to achieve two percent.

7. Remedy Selection and Protection of Human Health and the Environment

The analytical data collected during the Remedial Investigation (RI) and baseline risk assessment indicated the presence of contaminants at the Himco Dump Superfund Site in soil and ground water that may present a risk to human health and the environment. The major exposure pathways of concern are from ingestion, inhalation, and direct contact with the landfill waste mass and contaminated soils in the construction debris area. The continued release of leachate into the ground water aquifer and outside the landfill boundaries also presents risk to human health and the environment. Environmental risk may also result from the release of landfill fugitive dust into the air.

The cover system alternative identified as the remedy in the ROD provided the greatest reduction of risk because in addition to containing the wastes in the landfill and the contaminated surface soil, the composite cap provides an added level of landfill gas containment and greater control of infiltration into the waste mass, thereby minimizing the potential release of leachate into the ground water and other media outside of the landfill boundaries (the composite cap greatly reduces the need for a leachate collection system).

Since the alternative cover system modeled varies from that specified in the ROD, overall protection of human health and the environment, and compliance with ARARs, are criteria that have to be reassessed if an alternative to the current design is to be constructed.

8. Recent Data Collection

Ground water and soil vapor samples were obtained recently and is currently being evaluated. Revaluation of the current design may be required based on the results of these investigations.

8.1. Ground Water

During ground water sampling, three inorganic constituents exceeded EPA Region 9 tap water Preliminary Remediation Goals (PRGs). Arsenic was detected at five locations at concentrations ranging from 3.6 to 24.3 μg/l, exceeding the tap water PRG of 0.045 μg/l. Iron was detected at two locations at concentrations ranging from 17,900 to 28,100 μg/l, exceeding the tap water PRG of 11,000 μg/l. Manganese was detected at one location at a concentration of 3,080 μg/l which exceeds the tap water PRG of 880 μg/l. No volatile or semivolatile organic compounds were detected above their PRGs. It has been reported to USACE - Omaha District that recent ground water samples have indicated 1, 1-dichloroethane (1, 1-DCA), 1, 2-dichloroethane (1, 2-DCA), 1, 2-dichloropropane, cis-1, 2-dichloroethene (cis-DCE), benzene, chloroform, and vinyl chloride in residential wells.

8.2. Soil Vapor

Multiple organic volatiles were detected in soil vapor samples. The compounds have been organized by functional groups to more clearly present the data. The most predominant group in terms of concentrations detected are the chlorinated ethenes, followed in decreasing concentrations by the chlorinated ethanes and benzene, toluene, ethylbenzene and xylene (BTEX) compounds. The highest concentrations of BTEX appear to be centered at sample locations TT-13, TT-18, and TT-26. The highest concentrations of chlorinated ethenes occur at locations TT-14, TT-19, and TT-26. The chlorinated ethanes follow the same pattern as the chlorinated ethenes. All compounds appear to be distributed similarly with the more elevated concentrations noted just off the south boundary of the landfill, and a decreasing trend moving away from the landfill perimeter. In all cases the highest detected concentrations are located in the southeast corner of the site just northwest of the intersection of County Road 10 and John Weaver Parkway.

9. Conclusions

This AAS was performed to determine alternative recommendations for the Himco Dump Superfund Site cover system. Criteria for evaluating alternative recommendations are protection of human health and the environment, cost effectiveness, and compatibility with future reuse. Protection of human health and the environment was evaluated via the HELP model. The HELP model was used to estimate the average annual percolation/leakage through each cover system configuration. Alternative recommendations for the Himco Dump Superfund Site were developed based on this AAS and are presented in Section 4. Alternative cover systems that meet the recommendations presented in Section 4 are equivalent to the composite barrier system required by the ROD and the intent of RCRA Subtitle C is met. Selection of one of the alternative recommendations will require an extensive CQA/CQC program to ensure the best possible installation quality.

Only the cover system component of the ROD was evaluated for the AAS. The remaining ROD components remain as part of the site remedy. Design issues such as vegetation considerations, head on the liner material, or slope stability require additional analyses for the final design. Revaluation of the current design may also be required due to recent ground water and soil gas data collected (USACE, 1999).

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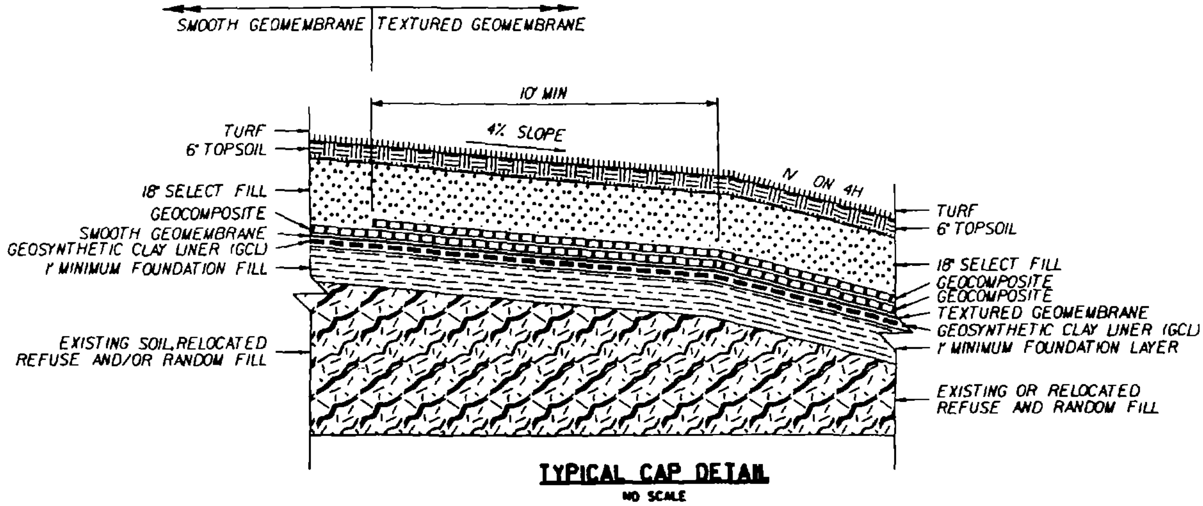

Figure 1 – Current Design (ROD Alternative 4)

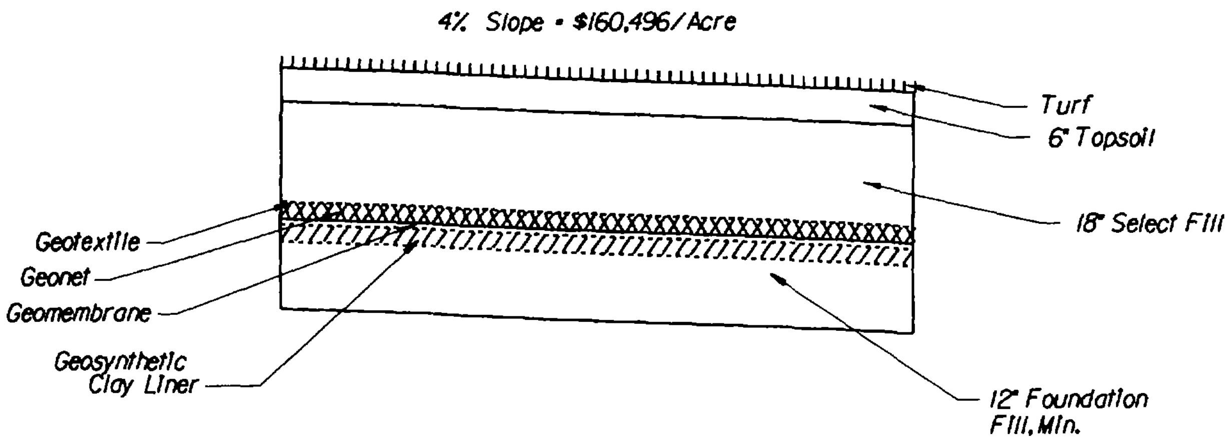

Figure 2 – Current Design as Modeled
No Scale

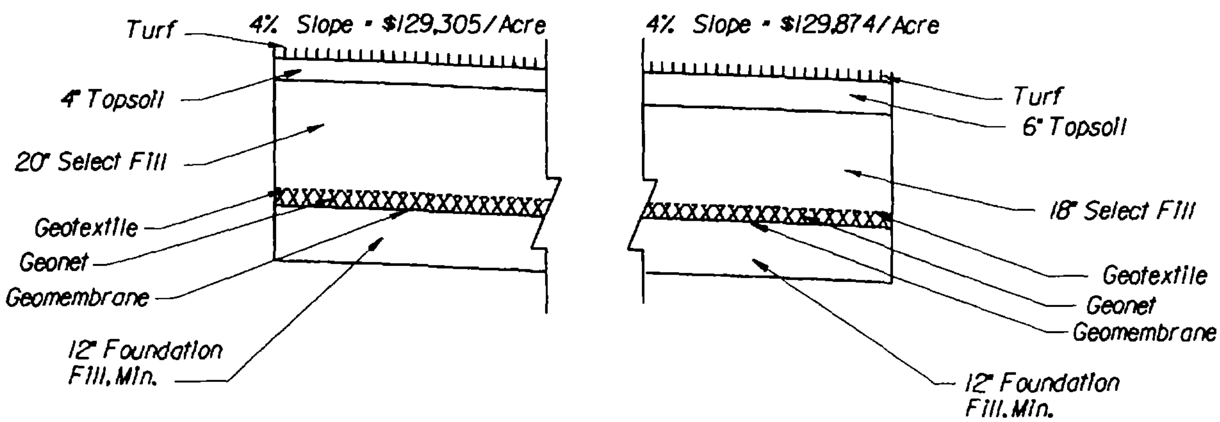

Figure 3 – Geonet Drainage Layer Alternatives Modeled
No Scale

Table 1 - *Modeling Cross Section Summary for Current Design*
(See Figure 2)

Layer	Layer Type	Layer Thickness (inches)	Material Texture Number	Material or USCS *Classification* (Saturated Hydraulic Conductivity, cm/sec)	Function/Description	Lateral Drainage Slope (percent)	Lateral Drainage Length (feet)	Geomembrane Defects (pinholes per acre) Manufacturer	Geomembrane Defects (pinholes per acre) Installation	Geomembrane Placement Quality
1	1 - Vertical Percolation	6	6	SM ($7.2X10^{-4}$)	Vegetative Layer	4	500	-	-	-
2	1 - Vertical Percolation	18	10	SC ($1.2X10^{-4}$)	Water Storage Layer	-	-	-	-	-
3	2 - Lateral Drainage	0.20	20	Geonet (10)	Drainage Layer	4	500	-	-	-
4	4 - Flexible Membrane Liner	0.04	35	40 mil HDPE ($2.0X10^{-13}$)	Geomembrane	======>		4	3	Good
5	3 - Barrier Soil Liner	0.20	17	GCL ($3.0X10^{-9}$)	Geosynthetic Clay Liner	-	-	-	-	-

Table 2 - Modeling Cross Section Summary For Geonet Drainage Layer Alternatives
(See Figure 3)

Layer	Layer Type	Layer Thickness (inches)	Material Texture Number	Material or USCS Classification (Saturated Hydraulic Conductivity, cm/sec)	Function/Description	Lateral Drainage Slope (percent)	Lateral Drainage Length (feet)	Geomembrane Defects (pinholes per acre) Manufacturer	Geomembrane Defects (pinholes per acre) Installation	Geomembrane Placement Quality
1	1 - Vertical Percolation	**4** **6**	6	SM ($7.2X10^{-4}$)	Vegetative Layer	**2** **4**	500	-	-	-
2	1 - Vertical Percolation	**20** **18**	10	SC ($1.2X10^{-4}$)	Water Storage Layer	-	-	-	-	-
3	2 - Lateral Drainage	**0.20**	**20**	**Geonet (10)**	Drainage Layer	**2** **4**	500	-	-	-
4	4 - Flexible Membrane Liner	0.04	35	40 mil HDPE ($2.0X10^{-13}$)	Geomembrane	======>		4	3	Good
5	**1 - Vertical Percolation**	**24**	**10**	**SC ($1.2X10^{-4}$)**	Subgrade	-	-	-	-	-

Notes: **Shading indicates variations modeled within a layer.**
Soil cover layers thickness (above geosynthetics) total 24 inches.
Lateral drainage slope for the Vegetative (1) and Drainage Layers (3) were identical.

Table 3 – Normal Mean Monthly Precipitation Input

Month	Normal Mean Monthly Precipitation (inches)	
	Normal	Irrigated
January	2.48	2.48
February	1.99	1.99
March	3.05	3.05
April	4.06	4.85
May	2.81	5.91
Jun	3.94	6.88
July	3.67	7.25
August	3.94	7.09
September	3.22	6.42
October	3.22	5.32
November	2.83	2.83
December	2.95	2.95

Note: Shading indicates assumed growing season with modified precipitation.

Table 4 – Modeling Summary Sorted by Increasing Cover System Percolation/Leakage

Topsoil Thickness (inches)	Select Fill Thickness (inches)	Lateral Drainage Slope (percent)	Drainage Layer Material	Barrier Layer Material	Output File Name	Average Annual Percolation/Leakage Through Cover System (inches)	(cubic feet)	(gallons)	Cover System Hydrologic Efficiency (percent)	Unit Cost ($/acre)
6	18	4	Geonet	GCL	FNGNGMGC (RCRA C/Current Design)	**0.00003**	**5.330**	**39.871**	99.99993	160,496
					GIGNGMGC (RCRA C/Current Design)	**0.00008**	**15.273**	**114.250**	99.99986	
4	20	4	Geonet	None	FN44GNGM	**0.00802**	**1,577.243**	**11,798.600**	99.97863	129,305
6	18	4	Geonet	None	FN64GNGM	**0.00855**	**1,681.024**	**12,574.930**	99.97722	129,847
4	20	4	Geonet	None	GI44GNGM	**0.02045**	**4,019.313**	**30,066.550**	99.96341	129,305
6	18	4	Geonet	None	GI64GNGM	**0.02250**	**4,422.064**	**33,079.340**	99.95975	129,847

Table 5 – Modeling Summary Sorted by Increasing Cover System Unit Cost

Topsoil Thickness (inches)	Select Fill Thickness (inches)	Lateral Drainage Slope (percent)	Drainage Layer Material	Barrier Layer Material	Output File Name	Average Annual Percolation/Leakage Through Cover System (inches)	(cubic feet)	(gallons)	Cover System Hydrologic Efficiency (percent)	**Unit Cost ($/acre)**
4	20	4	Geonet	None	FN44GNGM	0.00802	1,577.243	11,798.600	99.97863	**129,305**
					GI44GNGM	0.02045	4,019.313	30,066.550	99.96341	
6	18	4	Geonet	None	FN64GNGM	0.00855	1,681.024	12,574.930	99.97722	**129,847**
					GI64GNGM	0.02250	4,422.064	33,079.340	99.95975	
6	18	4	Geonet	GCL	FNGNGMGC (RCRA C/Current Design)	0.00003	5.330	39.871	99.99993	**160,496**
					GIGNGMGC (RCRA C/Current Design)	0.00008	15.273	114.250	99.99986	